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GMPLS Signaling Protocol Interoperability Test in Multilayer Network

Establishing a global standard for the next-generation photonic network

Fujitsu Laboratories Ltd.,Nippon Telegraph and Telephone Corporation,NEC Corporation,The Furukawa Electric Co., Ltd.,Mitsubishi Electric Corporation

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Nippon Telegraph and Telephone Corporation (NTT; Head Office: Chiyoda-ku, Tokyo; President: Norio Wada), NEC Corporation (Office: Minato-ku Tokyo; President: Akinobu Kanasugi), Fujitsu Laboratories Ltd. (Office: Kawasaki-shi; President: Michio Fujisaki), The Furukawa Electric Co., Ltd. (Office: Chiyoda-ku; President: Junnosuke Furukawa), and Mitsubishi Electric Corporation (President & CEO: Tamotsu Nomakuchi) are pleased to announce the successful conclusion to the world's first Generalized Multi-Protocol Label Switching (GMPLS)[(1)]signaling[(2)] interoperability test using a multilayer network consisting of packet, Time Division Multiplexing (TDM)[(3)], wavelength, and fiber layers. Given the quality requirements set by the application or traffic state, it is possible to select the optimal communication path from among all possible paths that can be established on the multilayer network.

The results of this experiment will be reported on May 22, 2003 in the Workshop held in Kagoshima University organized by the Technical Group on Photonic-Network-based Internet (PNI) and the Technical Group of Photonic Switching (PS) in IEICE (The Institute of Electronics, Information, and Communication Engineering).

Backgrounds and Achievements GMPLS is a technology that enables unified control management of the network layers (packet / TDM / wavelength / optical fiber). In the conventional network, each layer network, such as packets (like IP), TDM, and wavelength is independently built. Conventional technology demands that each network layer be independently controlled by operators who specialize in the corresponding network layer. For example, in the conventional electric or optical cross-connect, the network operator administers the terminal of the centralized control device. This device issues instructions to control cross-connect equipment and thus the setup of TDM or wavelength paths. When the cross-connect equipment supports GMPLS control, path setup is established by exchanging control packets between these control devices as well as MPLS routers. Therefore, network operator who has MPLS expertise can manage cross-connects. However, present equipment that supports GMPLS control simply offers a unified management approach. Each layer network (IP, TDM, or wavelength) must still be managed separately as before. It is impossible to handle all layers in the whole network systematically, such as one side routing using TDM paths where the other side routing uses wavelength paths.

In order to avoid this problem, control software programs for setting up and releasing paths in the multilayer network were newly developed and mounted into the network control devices of each company. The fact that these control devices can be mutually interconnected is a key factor in the success of the interoperability test that examined path setup of multilayer signaling; a world first. These control devices exchange signals based on protocol of RSVP-TE[(4)] extended to GMPLS to set up and release multilayer paths on the multilayer network.

The setup examined the test is shown in Figure. This setup was designed to replicate a multilayer network with various kinds of network equipment including packet routers, electrical-connects, optical cross-connects, and optical switch for fiber port switching. It provides control functionality for both packet paths and TDM paths using control devices 1 and 2. Control device 1 can freely set the packet path of route A, and the TDM path of route B. Control device 2 on Route A has path control functions for both packet and wavelength paths. Control devices 2-6 are for optical cross-connect control, by which the paths of wavelength are set up. They newly set up a wavelength path for the packet path from 1 to 7. Thus, the setup and release of a multilayer path can be performed by exchanging a control signal between each control device handling a different layer. Given the quality requirements set by the application or traffic state, it is possible to select the optimal communication path from among all possible paths that can be established on the multilayer network.

Due to the use of GMPLS, network operation can be unified. Significant reductions in network operation cost can be expected because the most economic path can be selected by configuring the optimal configuration of network resource from among all layers of the network. In addition, novel network services can be created, such as the wavelength-dedicated line which changes wavelength path connection points according to user demand. For this reason, GMPLS has been attracting attention as the base technology of the next-generation broadband IP network. GMPLS is being actively discussed and advanced in international standardization organizations, such as IETF (Internet Engineering Task Force), OIF (Optical Internetworking Forum), and ITU (International Telecommunication Union).

A future plan This interoperability test was carried out by the Photonic Internet Lab (PIL)[5] , which was founded in order to promote research on and development of the next-generation photonic network[6] as well as encouraging global standardization activities. PIL was founded in September 2002. At present, PIL consists of seven companies; Oki Electric Industry Co., Ltd. and Hitachi, Ltd. are additions to the five above-mentioned companies. PIL has two objects: one is to create new control technologies that can be accepted as international standards. The second to rigorously test the protocol software code developed by each company. We are planning to conduct interoperability tests with a number of global companies.

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[1] Generalized Multi-Protocol Label Switching (GMPLS)

Generalized Multi-Protocol Label Switching is a protocol that establishes generalized MPLS into all layers of the IP network: layer 2, TDM (Time Division Multiplexing), wavelength (WDM), and the fiber. The basic MPLS is a control mechanism that attaches fixed length labels to IP packets. GMPLS is attracting attention for controlling the next-generation photonic network. Standardization of GMPLS is being advanced mainly by IETF (The Internet Engineering Task Force). The basic function of GMPLS was released as a Proposed Standard in February 2003, with registration number RFC 3471-3473. In order to make it complete and a truly practical protocol, world-wide efforts are needed elaborate the remaining details and develop protocol code that can be directly installed in network equipment.

[2] signaling

Operation which exchanges signals between the control devices of network equipment, such as routers and optical crossing connects in order to set up and release paths. The format of the control signal and the procedure to exchange control packets are defined in the signaling protocol.

[3] Time Division Multiplexing (TDM)

Transmitting technology using time division multiplexing. SDH/SONET is used widely in many networks.

[4] RSVP-TE

One of the protocols for signaling ,that is, to setup a path and release it. Extended for MPLS from RSVP. The original RSVP is a protocol for bandwidth reservation.

[5] Photonic Internet Lab (PIL)

PIL is promoting research into and development of next-generation photonic network technologies (See http//www.jk.ws32.arena.ne.jp). PIL encourages the submission of proposals from its members to global standardization bodies, like ITU-T, IETF, and OIF. PIL also tests the photonic network control programs developed by PIL member companies. PIL activities are supported by the R&D support scheme of the MPHPT (Ministry of Public Management, Home Affairs, Posts and Telecommunications) for funding selected IT activities.

[6] next-generation photonic network

A network that more fully realizes the benefits of optical technology; like optical fiber transmission, wavelength division multiplexing, and so on. At present, optical fiber and wavelength multiplexing are mainly used for point to point transmission. The next-generation photonic network demands effective optical switching technology. Most current switches are electrical because the few existing optical switches offer insufficient performance. A high-speed and large-scale network can be created if advanced optical switching technology (the optical signal is switched without optical-electrical conversion) can be realized.

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Founded in 1968 as wholly owned subsidiary of Fujitsu Limited, Fujitsu Laboratories Limited is one of the premier research centers in the world. With a global network of laboratories in Japan, China, the United States and Europe, the organization conducts a wide range of basic and applied research in the areas of Multimedia, Personal Systems, Networks, Peripherals, Advanced Materials and Electronic Devices.

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